The IAC's Near Infrared Camera

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Abstract. Here we report the main characteristics of the recently acquired near infrared camera. It is based on a 256 x 256 HgCdTe Nicmos-3 array, sensitive from 1 μm to 2.5 μm. The pixel size is 40 μm x 40 μm, adequate for the spatial and spectral scales at the different telescopes operating at the observatories of La Palma and Tenerife. The cooling system operates with LN2 with a hold time larger than 20 hours. The camera will be used for photometric, spectroscopic and spectropolarimetric observations.

1. Introduction

Until a few years ago, due to the lack of imaging near-infrared detectors, most of the observational works were done in the visible range of the spectrum. Nowadays, such detectors are already available and a number of papers emphasize the importance and quality of the data that can be obtained using them (see, v.g., Rabin, Jefferies & Lindsay, 1995). There are a number of advantages when observing in the near-infrared spectral range. On the one hand, the influence of the earth's atmosphere is considerably less in the near infrared. The Fried's parameter, r₀, (which indicates the maximum size of a telescope not affected by seeing) varies as λ^{6/5} (Fried, 1965). A value of r₀ of 12 cm at 500 nm would imply at 1.6 μm a value of 48 cm, close to the diameter of most of the ground-based solar telescopes. Thus, while visible images would be clearly affected by seeing, the spatial resolution in the near infrared is mainly limited by the optical system used. Despite the theoretical resolution of the telescopes at these wavelengths is lower, it is still good enough to make possible high angular resolution observations. For instance, at the VTT of the Observatorio del Teide (with a diameter of 70 cm), the theoretical resolution is 0.58 arcseconds at 1.6 μm, far from the 0.3 arcseconds obtained with the best visible images from the Swedish Tower of the Observatorio del Roque de los Muchachos, but still good enough, especially for spectroscopic works. Despite the large integration times in spectroscopy, due to the lack of photons, it is expected to have similar spatial resolutions in visible and near-infrared spectra.

On the other hand, the magnetic splitting is considerably larger in the near infrared. While the width of spectral lines increases proportionally to λ, the magnetic splitting does as λ². The net effect is that at 1.6 μm we are three times more sensitive to magnetic field than at 500 nm. In other words, for observations
with the same signal to noise ratio, it will be possible to detect fields about three times smaller. Thus, infrared observations will give considerable hints to understand the physics of facular, network, weak and intra-network magnetic field structures.

In addition, the continuum opacity is minimum at 1.6\(\mu\)m, allowing the observation of deeper solar atmospheric layers.

For all these reasons, the IAC has acquired a near-infrared camera to increase the observational capabilities of the canarian observatories. It will be used at the Swedish Tower at La Palma and at the German telescopes at Tenerife, either for photometric or spectroscopic observations. In particular, a polarimeter based on this camera and using ferroelectric liquid crystals as modulators is currently being developed for the detection of spectropolarimetric signals (see Sánchez Almeida et al., this volume).

In the following we report the main characteristics of the camera.

2. Detector

The camera is based on a Rockwell HgCdTe NICMOS-3 256\(\times\)256 detector, sensitive from 1\(\mu\)m to 2.5\(\mu\)m. This array is one of the most well-known detectors used in near infrared astronomy. Its low noise, high quantum efficiency and working temperature suit it to the above mentioned applications. Examples of use of the NICMOS-3 can be found elsewhere. We report here the infrared camera installed at the 1.5m telescope at the Observatorio del Teide, developed by our Technology division.

The general characteristics of the detector are summarized in table 1.

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<tr>
<th>Table 1. Detector characteristics</th>
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<tr>
<td>Size</td>
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<tr>
<td>Cooling</td>
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<tr>
<td>Wavelength range</td>
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<td>Pixel distance</td>
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<td>Filling factor</td>
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<td>Quantum efficiency</td>
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3. Electronics

The electronics for reading the detector, the synchronization and bias signals, and the preamplification and digitization stages have been provided by Infrared Labs, Tucson, USA. Table 2 indicates the properties of the measured signal including all the electronic elements.

The system is designed with a VME architecture which allows compatibility with many existing developing tools and systems. Through the use of PGAs (Programmable Gate Arrays) flexibility is assured to handle the synchronization...
and bias signals as desired to adequately read the chip. The design of the electronics is such that it can be easily upgraded to handle a larger 1024K pixel array, adding the necessary memory modules and upgrading the programming of the PGA’s. Data is transferred via fiber optics (80 MBytes/s) to a control unit, which re-sends it, using an RS-422 interface, to the central computer. Commands can be sent from the central computer to the camera through an RS-232 interface. More details can be found in Turner & Hanna (1995).

4. Mechanics

The cryostat has been designed and constructed at Infrared Labs. It consists of two vessels to ensure cooling in two stages. The outer vessel has a capacity of 2 lt of LN2, while the inner one is of 1 lt. The outer vessel temperature hold time is ~ 20 hours, and that of the inner one is larger than one day. Due to the different optical design of the telescopes where the camera is intended to be used, it has been designed such that it can be operated in horizontal and vertical positions. A cooled filter wheel, with 4 positions is included inside the cryostat. Presently, three filters (J, H & K) are placed, while the fourth position will be blocked for dark current measurements. The wheel has a motor to control it automatically from the central computer. No optics has been added to the design. Figures 1 and 2 show several diagrams, provided by Infrared Labs., of the cryostat.

5. General Control and Software

The central computer will be a Digital Alpha Workstation. The user’s interface and control software will be developed at the IAC. For photometric purposes, a digital frame selection utility will be incorporated. For spectropolarimetric purposes, the system will control the modulating devices (ferroelectric liquid crystals) while acquiring simultaneously images. Individual frames will be added to increase the signal to noise ratio (see Sánchez Almeida et al., this volume).

First light will be obtained by means of a simplified data acquisition system. This system consists of a PCI-frame grabber board from Bitflow and a high-speed Pentium based computer. The user interface in this simplified system is being developed under Windows Visual Basic Language. This will also allow us, in an easy way, to test the different cycles of the camera, each one adapted for the very different astronomical applications, providing us a very flexible infrared
camera system. The complex final instrument, based on the mentioned DEC workstation and in a powerful PGA programmable PCI-Pamette board, will control the entire polarimetric application.

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References

Figure 2. Two section views of the cryostat